AFFTC-PA-10058

# Edwards Air Force Base Accelerates Flight Test Data Analysis Using MATLAB® and Math Works™

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**PRESENTED ON:**
**10 June 2010**

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**EDWARDS AIR FORCE BASE, CALIFORNIA**
**AIR FORCE MATERIEL COMMAND**
**UNITED STATES AIR FORCE**

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| **1. REPORT DATE** *(DD-MM-YYYY)* | **2. REPORT TYPE** | **3. DATES COVERED** *(From - To)* |
|---|---|---|
| 03-02-10 | User Conference Presentation | 06-08-10- 06-10-10 |

**4. TITLE AND SUBTITLE**
Edwards Air Force Base Accelerates Flight Test Data Analysis Using MATLAB® and Math Works™

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**
John Bourgeois

**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES)**
307 E Popson Ave
812 TSS/ENTT
Bldg 1400
Edwards AFB, CA 93524

**8. PERFORMING ORGANIZATION REPORT NUMBER**
AFFTC-PA-10058

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
307 E Popson Ave
812 TSS/ENTT
Bldg 1400
Edwards AFB, CA 93524

**10. SPONSOR/MONITOR'S ACRONYM(S)**
N/A

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for public release A: distribution is unlimited.

**13. SUPPLEMENTARY NOTES**
CA: Air Force Flight Test Center Edwards AFB CA CC: 012100

**14. ABSTRACT**
Provides a basic overview of the analysis using MATLAB® and Math Works™, Computing Tools for the Math Works 2010 Advisory Board for Aerospace and Defense conference.

**15. SUBJECT TERMS**
**Global Hawk, MATLAB®, Parallel, Computing, Distributed Computing, Simulink**

| **16. SECURITY CLASSIFICATION OF:** | | | **17. LIMITATION OF ABSTRACT** | **18. NUMBER OF PAGES** | **19a. NAME OF RESPONSIBLE PERSON** |
|---|---|---|---|---|---|
| **Unclassified** | | | | | 412 TENG/EN (Tech Pubs) |
| **a. REPORT** | **b. ABSTRACT** | **c. THIS PAGE** | | | **19b. TELEPHONE NUMBER** *(include area code)* |
| Unclassified | Unclassified | Unclassified | None | 5 | 661-277-8615 |

**Standard Form 298 (Rev. 8-98)**
**Prescribed by ANSI Std. Z39.18**

## Edwards Air Force Base Accelerates Flight Test Data Analysis Using MATLAB® and MathWorks™ Parallel Computing Tools

By John Bourgeois, Edwards Air Force Base

Before equipping the Global Hawk unmanned aerial reconnaissance system with multimillion-dollar, one-of-a-kind sensor prototypes, the U.S. Air Force conducts extensive performance and flying qualities flight tests. Unlike manned flight tests, which last only a few hours, a Global Hawk flight test can last up to 30 hours. All test data must be processed and analyzed before the aircraft is cleared for the next flight—a considerable challenge when up to 70 maneuvers are performed and up to 20 gigabytes of data are produced per flight.

A Global Hawk test flight.

Engineers at Edwards Air Force Base (AFB) accelerated flight test data analysis by using MATLAB® and MathWorks™ parallel computing tools to run the data-intensive tasks on a computer cluster. The resulting decrease in processing time enabled the team to keep pace with the flight test schedule.

### The Challenge

Air Force engineers frequently process flight test data using a Fortran-based application called Uniform Flight Test Analysis System (UFTAS). Now more than 30 years old, UFTAS is difficult to configure for new aircraft programs. Documentation for large areas of UFTAS is sparse or missing. Additionally, developing a new flight test program using the system is time-consuming: putting together a new program and getting it running could take months.

Edwards AFB needed a development platform that would enable its engineers to build an updated, easier-to-use version of UFTAS.

The team also needed to accelerate the analysis of gigabytes of flight test data containing hundreds of parameters recorded at up to 50 measurements per second.

To prepare for the next test flight, the engineers needed to review data analysis results from the previous flight and make the necessary adjustments. This requirement meant that, no matter how large the data set, analysis had to be completed within the limited time between flight tests.

### The Solution

Edwards AFB engineers developed MUFTAS, a MATLAB® based version of UFTAS. With Parallel Computing Toolbox™ and MATLAB Distributed Computing Server™, they analyzed data from multiple flight maneuvers simultaneously on a computer cluster with 16 dual-core, 2.61 GHz AMD® Opteron™ processors.

The team used MATLAB® functions to read and filter raw data from inertial navigation systems, air data systems, and other sensors aboard the aircraft. This data set includes measurements of inertial velocities, angular accelerations, total pressure, static pressure, air temperature, fuel quantities, and fuel flow.

Working in MATLAB®, they implemented classic flight test data algorithms that used the raw data to calculate air speed, altitude, Mach number, and flight path acceleration, as well as the aircraft's moments and products of inertia. They then plotted time histories of key parameters, including altitude, air speed, and acceleration.

To generate predictions for the aircraft's aerodynamics, Edwards AFB engineers used Simulink® to develop a six-degrees-of-freedom model that estimates forces and moments based on lookup tables of aerodynamic and propulsion data. They then generated aerodynamic parameter estimates using System Identification Programs for Aircraft (SIDPAC) software, which was developed in MATLAB® by Dr. Eugene Morelli at the NASA Langley Research Center.

After verifying the data analysis on desktop workstations, the team used Parallel Computing Toolbox to prepare the MATLAB® scripts to be executed by MATLAB® Distributed Computing Server workers running on the computer cluster.

The team validated the measured aircraft dynamics by comparing them with the dynamics derived from contractor-provided models and from SIDPAC estimations.

Edwards AFB engineers continue to use MathWorks tools to analyze Global Hawk data. Their results have been used to guide aircraft procurement decisions made by the Under Secretary of Defense for Acquisition, Technology and Logistics.

**The Results**

- **Analysis completed 16 times faster.** Parallel Computing Toolbox and MATLAB® Distributed Computing Server provided a one-for-one time savings with the number of processors used. For example, with a 16-processor cluster, throughput was 16 times higher, enabling Edwards AFB engineers to accomplish in hours tasks that used to take days.

- **Application parallelized in minutes.** Edwards AFB engineers set up MATLAB® Distributed Computing Server in half a day, enabling them to run their applications in parallel on the cluster. Changing the MATLAB® code to parallel MATLAB® code took less than 30 minutes. Moving the processing from workstations to the cluster enabled personnel to work on other things while the data-intensive processing was being run.

- **Program setup time reduced from weeks to days.** Engineers needed six weeks to set up a flight test program in the Fortran-based UFTAS. With the MATLAB® based system, the team can now set up a flight test program in less than one week.

**Learn more about Edwards AFB: *www.edwards.af.mil***

## Abstract Summary

**The Challenge**

Accelerate performance and flying qualities flight test data analysis for unmanned reconnaissance aircraft

**The Solution**

Use MathWorks parallel computing tools to execute MATLAB® flight data processing algorithms on a 16-node computer cluster

**The Results**

- Analysis completed 16 times faster
- Application parallelized in minutes
- Program setup time reduced from weeks to days

**Application Areas**

- Aerospace and defense
- Algorithm development
- Statistics and data analysis
- Parallel computing

**Products Used**

- MATLAB®
- Simulink®
- Parallel Computing Toolbox™
- MATLAB Distributed Computing Server™